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ON THE INFLUENCE OF CIRCUMSTANCES ON THE ACTIONS AND HABITS OF ANIMALS, AND THAT OF THE ACTIONS AND HABITS OF LIVING BODIES, AS CAUSES WHICH MODIFY THEIR ORGANIZATION.

BY J. B. P. A. LAMARCK.[1]

THE question here is not one of reasoning, but the examination of a positive fact, which is more general than is thought, and to which people have neglected to give the attention which it merits without doubt because, often, it is very difficult to recognize. This fact consists in the influence exercised by circumstances on the different living bodies, which find themselves subjected to them. In fact, the influence of different states of our organism on our character, our inclinations, our actions, and also our ideas, has been long remarked; but it seems to me no one yet has recognized what influence our actions and our habits have upon our organization itself. Now, as these actions and these habits depend entirely upon the circumstances in which we habitually find ourselves, I will attempt to point out how great is the influence which circumstances exercise on the general form, on the condition of parts, and thus upon the organization of living bodies. It is this very certain fact which is the question discussed in this chapter.

If we had not had numerous opportunities to recognize clearly the effect of these influences on certain living bodies which we have placed in altogether new circumstances, and very different from those to which they were accustomed, and if we had not seen the effects and changes which have resulted, exhibiting themselves in many ways, under our eyes, the important fact in question would always have remained unknown to us.

The influence of circumstances manifesting itself in bodies possessing life, is effectual in all time and everywhere; but that which renders this influence difficult for us to perceive, is that these effects only become sensible or recognizable (especially among animals) after a long time.

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[1] Constituting the Chap. VII., Vol. I., of the Philosophie Zoölogique. Translated for the American Naturalist by Dr. Eleanor E. Galt, from the edition of 1809.

Before showing and examining the proofs of these facts, which deserve our attention, and which are of great importance to Philosophical Zoology, let us again take up the thread of considerations which we have already had in hand.

In the preceding chapter we have seen that it is at present an incontestable fact that in considering the animal scale in an inverse sense to that of nature, we find that there exists in the bodies which compose this scale a continual but irregular degradation in the organization of the animals which compose it; a growing simplification of the organization of living bodies, and finally a proportional diminution in the number of faculties of these beings.

This well-known fact throws the greatest light upon the order which nature has followed in the production of all existing animals; but it does not point out to us why the organization of animals in its growing constitution, from the most imperfect up to the most perfect, shows only irregular gradation, of which the facies presents numerous anomalies or digressions, having no appearance of order in their diversity.

Now, in searching for the reason of this singular irregularity in the growing constitution of the organization of animals, if we consider the result of the influence which circumstances, infinitely diversified in all parts of the globe, exercise on the general form, the parts, and the organization itself of the animals, all then will be clearly explained.

It will be, in fact, evident that the state in which we see all animals, is, on one side, the product of the growing constitution of the organization which tends to form a regular gradation, and, on the other side, that it is the influence of a multitude of very different circumstances which are tending continually to destroy the regularity in the gradation of the growing constitution of the organization.

Here it becomes necessary to explain myself as to the meaning which I attach to these expressions: *The circumstances influence the form and organization of animals,* that is to say, that in becoming very different they change in time both their form and their organization itself, by proportional modifications. Surely, if these expressions were taken literally, an error would be ascribed to me; for, whatever the circumstances might be, they would not produce directly any modification whatever in the form and organization of the animals.

But great changes in circumstances bring among animals great changes in their wants, and changes in their wants necessarily bring parallel modifications into their actions. Now, if the new wants become constant or very lasting, the animals will adopt new habits, which are as permanent as the wants which produced them. This is a fact easy of demonstration, such as requires no explanation to be appreciated.

It is then evident that a great change in circumstances becoming constant in a race of animals, entails upon these animals new habits.

Now, if new circumstances becoming permanent with a race of animals, have given to these animals new habits; that is to say, have forced them to new actions, which have become habitual, the consequence will be the employment of some part, in preference to some other part, and in certain cases the total lack of employment of a part which has become useless.

Nothing of all this should be considered as an hypothesis, or as a private opinion; they are, on the contrary, truths which, in order to be rendered evident, require only attention and observation of facts. We shall see directly by the citation of known facts, which prove, on one side, that new wants, having rendered a certain part necessary, have really by repeated efforts created this part, and in consequence of repeated employment have little by little strengthened and developed them, and have resulted in a considerable increase of size. On the other hand, we shall see that in certain cases new circumstances and new wants having rendered a certain part entirely useless, the total lack of employment of that part has caused its growth gradually to cease; that it becomes small and attenuated little by little, and that finally, when this lack of employment has been total for a long time, the part in question disappears.

All this is certain, and I now propose to give the most convincing proof. In vegetables, which have no movements, and in consequence no habits, properly speaking, great changes of circumstances bring great differences in the development of their parts, so that these differences create and develop some of them, whilst they diminish and abolish others.

But here all goes on by changes wrought in nutrition of the vegetable, in its absorptions and its respirations, in the quantity of caloric, of light, of air and humidity, which it then habitually receives; finally in the superiority which certain of the diverse vital movements may exercise over the others.

Among individuals of the same species, some of which are continually well nourished, and under circumstances favorable to their development, while others are subjected to opposite conditions, there will be produced a difference of development which gradually becomes very well marked. How many examples could I not cite in regard to animals and vegetables which would confirm this assertion! Now, if circumstances remaining the same, render the state of badly nourished, suffering or languishing individuals habitual and constant, their interior organization is finally modified; and reproduction among these individuals in question preserves these acquired modifications, and at last gives origin to a race very distinct from that whose individuals are found continually in circumstances favorable to their development. A very dry spring is the reason why the grasses of a meadow grow very little and are meagre and mean, although they blossom and fruit. A spring time of warm and rainy days causes the same grasses to take on much growth, and the harvest of hay is then excellent. But if any cause perpetuates unfavorable circumstances for these plants, they will vary proportionally, at first in their appearance or general condition, and finally in various particulars of their characters. For example, if some seed of any one of these grasses of the meadow in question, be transferred to an elevated locality, dry, arid, stony, and much exposed to winds, and there germinate, the plant which will live in this locality, though always badly nourished, and the individuals which it reproduces then continuing to exist under these adverse circumstances, there will result a species very different from the species living in the meadow, from which it has originated. The individuals of this new race would be small, slender in their parts, and certain of their organs having developed more than others, would then present peculiar proportions.

Those who have observed much, and who have consulted great collections, have been able to convince themselves that, according as the circumstances of habitat, of exposure, climate, nourishment and habit of life, etc., change; the characters of size, form, proportion of parts, color, consistence, activity and labors, of animals change in proportion. That which nature does slowly we can do every day, by changing suddenly, in the case of a living vegetable, the circumstances by which it and all the individuals of its kind are surrounded. All botanists know that vegetables which are taken from their native place into gardens to be cultivated, gradually undergo changes which render them finally unrecognizable. Many plants naturally very hairy become smooth, or nearly so; numbers of those which were creeping and trailing, straighten their stems; others lose their spines or their roughness; still others possessing woody and long-lived (perennial) stems in warm climates which they inhabited, pass, in our country, into an herbaceous state (many are only annual plants); finally the dimensions of their parts undergo very considerable changes. These effects of changes of circumstances are so well known that botanists do not like to describe garden plants unless they have been recently cultivated. Is not cultivated wheat (*Triticum sativum*) a vegetable, brought by man to the state in which we actually see it? Who can tell me in what country a like plant has its habitat without being there the result of culture? Where do we find in nature our cabbages, our lettuces, etc., in the state in which we possess them in our kitchen gardens? Is it not the same in regard to many animals which domestication has changed or considerably modified? How many different races among our poultry and domestic pigeons have we procured by raising them under diverse circumstances and in different countries, and how vain would be our search to find such in nature! Those which are the least changed, without doubt by less ancient domestication, and because they do not live in a climate strange to them, present no less, in the condition of certain of their parts, great differences, produced by habits which we have caused them to contract. Thus our domestic ducks and geese find their type in wild ducks and geese; but ours have lost the power to rise high in the air, and to traverse great distances by flying; there has been, in fact, a real change in the state of their parts, compared with those animals of the race from which they came. Who does not know that any bird of our climate which we have raised in a cage, and which has lived there five or six years, continuously, when liberated is not able to fly as its kind who have always been free? This trifling change of circumstance acting on this individual, has in truth only diminished its faculty of flight, and without doubt has made no change in the form of the parts of the individuals. But if successive generations of individuals of the same race had been held in captivity during a considerable time, there is no doubt that even the form of the parts would little by little have undergone notable changes. A stronger reason yet, if instead of a simple captivity maintained in regard to them, this circumstance has been for some time accompanied by a change of very different climate, and that these individuals by degrees had been habituated to other kinds of food, and to other movements to get it, certainly these circumstances united and become constant would have formed insensibly a new race altogether peculiar. Where is found now in nature the multitude of races of dogs which, in consequence of the domestication to which we have reduced them, have been brought into the condition in which they are at present? Where are found the bulldogs, greyhounds, spaniels and lapdogs, etc., races which show in themselves greater differences than those which we would admit as specific among animals of the same genus living at liberty in nature?

Without doubt a first and unique race, first cousin of the wolf, if not himself the true type, has been some time tamed and domesticated by man. This race, which showed at that time no difference among the individuals, has been gradually dispersed with man into different countries and into different climates, and after having long submitted to the influence of the places of habitation and the diverse habits which they have been made to contract in each country, they have experienced remarkable changes and have formed peculiar races. Now man, for the sake of commerce or for other interests, travels great distances; and having transported into well-peopled places, as a great capital, different races of dogs bred in countries far apart, and then crossed them, he has by generation given origin successively to all these which we now know.

The following fact proves, in regard to plants, how the change of some important circumstance acts to change the parts of these living bodies. While *Ranunculus aquatilis* is immersed in water its leaves are all finely divided and the divisions are capillary, but when the stems of this plant reach the surface of the water, the leaves which develop in air are enlarged, rounded and simply lobed. If some root of this plant succeeds in pushing itself into a soil only damp, without being covered by water, the stems are short, and none of the leaves are parted into capillary lobes; it is called the *Ranunculus hederaceus*, which botanists regard as a species when they encounter it. There is no doubt that, in regard to animals, important changes in the circumstances in which they are in the habit of living, produce changes likewise in their parts, but here the mutations are slower in being brought about than in vegetables, and in consequence are less evident to us, and their cause less recognisable. Among the circumstances which have so much power to modify the organs of living bodies, the most influential are, without doubt, the diversity of places which they inhabit; but besides these are many others which have considerable influence in the production of the results in question. It is known that different places change nature and quality on account of their position, of their constitution, and of their climate. This is easily observed in visiting different places distinguished by these particular qualities. Behold, then, one cause of variation of animals and of vegetables which live in these diverse localities; but that which is not sufficiently known, and even what is generally refused credit, is that each locality itself changes in time, exposure, climate, nature and quality, though so slowly in comparison with our lifetimes that we attribute to it perfect stability. Now, in one and the other case, these changed localities change correspondingly the relations to living bodies which inhabit them, bringing to bear new influences on them. It is known that when there are extremes in these changes there are gradations which are intermediate, and which fill the interval. Consequently there are shades of difference, which distinguish what we call species. It is therefore evident that the entire surface of the globe shows, in its nature and in the situation of the materials which occupy different localities, a diversity of circumstances which is everywhere in relation with that of the forms and of the parts of animals, independent of peculiar diversity which necessarily results from the progress of the composition of the organization in each animal.

In every place where animals have been able to live, the circumstances which have established there an order of things which has continued for a long time the same, and change is there really so slow that man has not been able to observe it directly. He is obliged to consult records, and monuments, and to recognize that in each one of these localities the order of things which he finds there has not always been the same, and thus to infer that it will still change. The races of animals which live in any of these places must preserve their habits for a long time, hence to us the apparent constancy of races which we call species—constancy which has given us the idea that these races are therefore as ancient as nature.

But at different points on the surface of the globe which are habitable, the nature and situation of the localities and the climates constitute for animals, as for vegetables, different circumstances in all kinds of degrees. Animals which inhabit these different localities must then necessarily become different from each other, not only by reason of the state of growth of the organization in each case, but besides by reason of habits which individuals of each race are forced to adopt. Therefore, in a measure, in traveling over great portions of the surface of the earth, the observing naturalist sees circumstances change in a gradual manner; he perceives constantly also that the species change proportionally in their characters. Now, the true order of things, which is the question to consider in all this, consists in recognizing,—

1st. That every change, of any importance, in the circumstances in which each race of animals exists, continually maintained, effects a real change in their necessities.

2d. That all change in the wants of animals necessitates for them new actions, in order to satisfy new wants, and consequently other habits.

3d. That every new want necessitating new actions to satisfy it, requires from the animal which experiences it, more frequent employment of some of its parts of which it made less use before. Thereby are developed and enlarged considerably the new parts which the wants have insensibly created in it by the efforts of its "interior sentiment." This is the question, as I will presently prove by known facts. To arrive at a knowledge of the true causes of so many diverse forms and so many different habits, of which known animals offer us examples, it is necessary to consider that the infinitely diversified circumstances, but slowly changing, which the animals of each race are continually encountering, produce for each of them new wants and necessarily changes in their habits. Now this incontestable truth once acknowledged, it will be easy to perceive how these new wants could be satisfied, and these new habits assumed, if we give some attention to the two following laws of nature, which observation has always proved to be constant:—

First Law.—In every animal which has not passed the time of its development the frequent and sustained employment of an organ gradually strengthens it, developes and enlarges it, and gives it power proportional to the duration of its use; whilst the constant disuse of a like organ weakens it, insensibly deteriorates it, progressively reduces its functions, and finally causes it to disappear.

Second Law.—All that nature acquires or loses in individuals by the influence of circumstances to which the race has been exposed for a long time, and in consequence by the influence of the predominate employment of such organ, or by the influence of disuse of such part, she preserves by generation, among new individuals which spring from it, providing the acquired changes be common to both sexes, or to those which have produced new individuals.

These are, then, two constant truths which cannot be misconstrued, except by those who have never observed or followed nature in her operations, or by those who entertain an error which I will combat. Naturalists having remarked that the forms of the parts of animals are always perfectly in harmony with the use of those parts, have thought that the forms and the conditions of the parts had caused their employment. Now this is an error, for it is easy to demonstrate by observation that on the contrary it is the wants and uses of the parts which have developed these same parts, that they are made to exist where they did not, and that consequently they have given place to the condition in which we observe them in every animal.

For, had this not been so, it would be necessary that nature should have created for the parts of the animal as many forms as the diversity of the circumstances in which they had to live would have required, and that these forms as these circumstances should never have varied. This is certainly not the order of things which exists, and if it were really such we would not have the race-horses of the form of those in England. We would not have great draught-horses, so heavy and so different from the former. For had not nature herself produced the like, we would not have, for the same reason, lapdogs with slender limbs, greyhounds so agile in running, water-dogs, etc. We would not have poultry without tails, peacocks, pigeons, etc.; finally we would not be able to cultivate wild plants, as we please, in the rich and fertile soil of our gardens, without fearing to see them change by long culture. For a long time there has been in this respect a sentiment which has established the following saying, which has passed into a proverb, which all the world knows, that "habits form a second nature." Surely if the habits and the nature of each animal never varied, the proverb would have been false, and would not have been used for the cases to which it had been applied.

If people considered seriously all that I have just shown, they would know that I was well grounded in reasons when, in my work entitled "Recherches sur les corps vivans," p. 50, I established the following proposition: "It is not the organ, that is to say, the nature and form of the parts of the body of an animal which have given origin to its habits and peculiar functions, but it is, on the contrary, its habits, its manner of life and the circumstances in which individuals from which it came, found themselves, which have after a time constituted the form of its body, the number and character of its organs, and finally the functions which it possesses. Let us weigh well this proposition, and give to it all the attention which nature and the condition of things continually gives us opportunity. Then its importance and its truth will become perfectly clear.

Time and favorable circumstances being, as I have already said, the two principal means which nature employs in giving existence to all her productions, it is evident that time has no limit for her, and in consequence she has it always at her disposal. Concerning these circumstances, which she requires, and which she still uses every day, to change all that which she continues to produce, they are in many ways inexhaustible to her. The principal proceed from the influence of climates, from that of diverse temperatures of atmosphere, and of all the surrounding media; that of the diversity of places, and of their situation; that of habits, of the most ordinary movements, of the most frequent actions; finally, of that of the means of self-preservation, of manner of life, of defence, of multiplication, etc. Now, by continuance of these diverse influences the faculties become expanded and strengthened by use, become diversified by new habits long maintained, and insensibly the conformation, consistence, in a word, the nature and condition of parts, also that of organs, participate in all these influences, maintaining and propagating themselves by generation.

These truths, which are only the result of the two natural laws expounded above, are in all cases strictly confirmed by facts; they indicate clearly the progress of nature in the diversity of her productions. But in place of contenting ourselves with generalities which may be considered as hypothetical, let us examine strictly the facts, and consider, in animals, the result of the use or disuse of their organs upon these organs themselves. According to the habits which each race has been forced to contract, I will prove that the constant lack of exercise, as regards an organ, diminishes at first its functions, gradually impoverishes it, and in the end makes it disappear, or annihilates it; so this disuse perpetuates itself for a long time thereafter in successive generations of animals of the same race. Afterwards I will show that, on the contrary, the habitual exercise of an organ in any animal which has not experienced a diminution of its functions, not only perfects and increases its functions, but otherwise makes it acquire the development and dimensions which insensibly change it, so that after a time it renders it different from the corresponding organ of another animal which exercises it much less.

The disuse of an organ having resulted in the habits which it has assumed, gradually impoverishes the organ, and finally makes it disappear, or obliterates it. As such a proposition could be admitted only on proof, and not on simple declaration, we will attempt to make it evident by the citation of known facts which constitutes its basis.

Vertebrate animals, of which the plan of organization is nearly the same, although they show much diversity in their parts, have, usually, their jaws armed with teeth. Nevertheless those among them which circumstances have given the habit of swallowing their food without previous mastication have been found to display a repressed development of these parts—that these teeth have even remained hidden between the osseous plates of the jaws without being able to appear, or all traces of them have entirely disappeared. Among whales, which people have believed completely deprived of teeth, M. Geoffroy has found them hidden in the jaws of the fœtus. This professor has also found in birds the groove where teeth should have been placed, but nothing more has been seen. In the class Mammalia, which embraces the most perfect animals, and principally those of which the plan of organization of the vertebræ is most completely executed, not only the whale has no teeth for its use, but one finds also in the same condition the ant-eater (Myrmecophaga), in which the habit of not masticating its food has been introduced and preserved for a long time in its race Eyes in the head is the rule for a great number of diverse animals, and are essential to the plan of the organization of vertebrates. Nevertheless the mole, which by its habits has very little occasion to see, has only very small eyes, and which scarcely show, because it exercises this organ very little.

"The Spalax d'Olivier" (Voyage en Egypt et en Persia, II., pl. 82, f. 2), which lives under ground like a mole, and which is probably less exposed to the light of day, and has totally lost the function of sight, shows scarcely the rudiments of the organ which is its seat, and these vestiges are entirely hidden under the skin and under whatever other parts which cover it, which allow no access of light. The Proteus, an aquatic reptile, cousin of the salamander, by all accounts lives in deep and obscure caverns, which are under ground, has, like the Spalax, only the traces of the organ of sight, which are covered and hidden in the same manner. Behold one decisive consideration relative to the question which I now discuss. Light does not penetrate everywhere, consequently animals which live habitually in those places where it does not come, lack occasion to exercise the organ of sight, if nature has provided them with it. Now, animals which partake in a plan of organization in which eyes necessarily enter, must have originally had them. And, since one finds among them species which are deprived of these organs, and which have only traces, hidden and covered, it becomes evident that the impoverishment and even the disappearance of the organ in question is the result of constant disuse.

[To be continued.]

ON THE GLACIAL DRIFT AND LOESS OF A PORTION OF THE NORTHERN-CENTRAL BASIN OF IOWA.

BY CLEMENT L. WEBSTER.

THE region under consideration may include Floyd county, and portions of Cerro Gordo, Worth, Mitchell, Chickasaw, Bremer, Butler, and Black Hawk counties. The general topography of this region is that of a gently undulating prairie country, with often a more or less broken surface along the course of the streams. Portions of Worth, Chickasaw and Bremer counties are low and rather wet, while that of other portions of the area are dryer and more rolling. The western portion of this region is drained mainly by Flood and Lime creeks and the Shellrock river, while the eastern portion is drained by the Cedar and Wapsipinecan rivers and their affluents.

All the streams of the area have a general northwest and southeast trend; their initial direction having been predetermined by the general dip of the subjacent rock strata. The Shellrock and Lime creeks have, for the most part, in their course through this region, eroded their channels through the drift, and into the underlying Devonian strata to a depth varying from five to seventy feet. The Cedar has cut through the drift, and sunk into the underlying rocks to a depth of from ten feet to over one hundred feet. The Wapsipinecan river and Flood creek flow through this country mostly upon the drift formation. The valleys